

# **CUPS Software Design Description**

CUPS-SDD-1.0

Easy Software Products

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# 1 Scope

## 1.1 Identification

This software design description document provides detailed information on the architecture and coding of the Common UNIX Printing System ("CUPS") Version 1.0.

## 1.2 System Overview

The Common UNIX Printing System provides a portable printing layer for UNIX® operating systems. It has been developed by Easy Software Products to promote a standard printing solution for all UNIX vendors and users. CUPS provides the System V and Berkeley command-line interfaces.

CUPS uses the Internet Printing Protocol (IETF-IPP) as the basis for managing print jobs and queues. The Line Printer Daemon (LPD, RFC1179), Server Message Block (SMB), and AppSocket protocols are also supported with reduced functionality.

CUPS adds network printer browsing and PostScript Printer Description ("PPD")-based printing options to support real world applications under UNIX.

CUPS also includes a customized version of GNU GhostScript (currently based off GNU GhostScript 4.03) and an image file RIP that can be used to support non-PostScript printers.

## 1.3 Document Overview

This software design description document is organized into the following sections:

- 1 – Scope
- 2 – References
- 3 – Design Overview
- A – Glossary



## 2 References

### 2.1 CUPS Documentation

The following CUPS documentation is referenced by this document:

- CUPS–CMP–1.0: CUPS Configuration Management Plan
- CUPS–IDD–1.0: CUPS System Interface Design Description
- CUPS–SAM–1.0.x: CUPS Software Administrators Manual
- CUPS–SDD–1.0: CUPS Software Design Description
- CUPS–SPM–1.0: CUPS Software Programming Manual
- CUPS–SSR–1.0: CUPS Software Security Report
- CUPS–STP–1.0: CUPS Software Test Plan
- CUPS–SUM–1.0.x: CUPS Software Users Manual
- CUPS–SVD–1.0.x: CUPS Software Version Description

### 2.2 Other Documents

The following non–CUPS documents are referenced by this document:

- IEEE 1387.4, System Administration: Printing (draft)
- IPP/1.0: Additional Optional Operations – Set 1
- RFC 1179, Line Printer Daemon Protocol
- RFC 2565, IPP/1.0: Encoding and Transport
- RFC 2566, IPP/1.0: Model and Semantics
- RFC 2639, IPP/1.0: Implementers Guide





## 3 Design Overview

CUPS is composed of 7 software sub-systems that operate together to perform common printing tasks:

- Backends
- Berkeley Commands
- CGI
- CUPS Interface Library
- Filters
- Scheduler
- System V Commands

### 3.1 Backends

The backends implement communications over a number of different interfaces. All backends are called with a common set of arguments:

- Device URI – the Uniform Resource Identifier for the output device (e.g. `parallel:/dev/plp`, `ipp://hostname/resource`).
- Job Identifier – the job identifier for this job (integer).
- User Name – the user associated with this job (name string).
- Title – the title/job-name associated with this job (name string).
- Copies – the number of copies required (integer).
- Options – the options associated with this job (space separated option strings).
- Filename (optional) – the file to print; if this option is not specified, the backend must read the print file from the standard input.

Backends are named using the method of the URI, so a URI of "ipp://hostname/resource" would be processed by the "ipp" backend.

#### 3.1.1 ipp

The ipp backend sends the specified job to a network printer or host using the Internet Printing Protocol. The URI is as specified by the `printer-uri-supported` attribute from the printer or host.

#### 3.1.2 lpd

The lpd backend sends the specified job to a network printer or host using the Line Printer Daemon protocol. The URI is of the form:

`lpd://hostname/queue`

#### 3.1.3 parallel

The parallel backend sends the specified job to a local printer connected via the specified parallel port device. The URI is of the form:

`parallel:/dev/file`

### 3.1.4 serial

The serial backend sends the specified job to a local printer connected via the specified serial port device. The URI is of the form:

```
serial:/dev/file?option[+option+...]
```

The options can be any combination of the following:

- `baud=rate` – Sets the baud rate for the device.
- `bits=7 or 8` – Sets the number of data bits.
- `parity=even` – Sets even parity checking.
- `parity=odd` – Sets odd parity checking.
- `parity=none` – Turns parity checking off.

### 3.1.5 socket

The socket backend sends the specified job to a network host using the AppSocket protocol commonly used by Hewlett–Packard and Tektronix printers. The URI is of the form:

```
socket://hostname[:port]
```

The default port number is 9100.

## 3.2 Berkeley Commands

The Berkeley commands provide a simple command–line interface to CUPS to submit and control print jobs. It is provided for compatibility with existing software that is hard coded to use the Berkeley commands.

### 3.2.1 lpc

The `lpc` command allows users and administrators to check the status and control print queues. The version provided with CUPS supports the following commands:

- `quit` – Quits the `lpc` command.
- `status` – Shows the status of printers and jobs in the queue.

### 3.2.2 lpr

The `lpr` command submits a job for printing. The CUPS version of `lpr` silently ignores the "i", "t", "m", "h", and "s" options.

### 3.2.3 lprm

The `lprm` removes one or more print jobs.

## 3.3 CGI

The Common Gateway Interface (CGI) programs provide a web–based status interface to monitor the status of printers, classes, and jobs.

### **3.3.1 classes.cgi**

The classes CGI lists the available printer classes and any pending jobs for the class. The user can click on individual classes to limit the display and click on jobs to see the job status.

### **3.3.2 jobs.cgi**

The jobs CGI lists the queued print jobs in order of priority. The list can be limited by printer or job. When the user displays the status of an individual print job all job options are displayed.

### **3.3.3 printers.cgi**

The printers CGI lists the available printer queues and any pending jobs for the printer. The user can click on individual printers to limit the display and click on jobs to see the job status.

## **3.4 CUPS Interface Library**

The CUPS interface library provides common convenience, HTTP, IPP, language, MIME, PPD, and raster functions used by the CUPS software.

### **3.4.1 Convenience Functions**

Convenience functions are provided to submit an IPP request, send a print file, cancel a job, get a list of available printers, get a list of available classes, get the default printer or class, get the default server name, get the local username, and get a password string.

### **3.4.2 HTTP Functions**

The HTTP functions provide functions to connect to HTTP servers, issue requests, read data from a server, and write data to a server.

### **3.4.3 IPP Functions**

The IPP function provide functions to manage IPP request data and attributes, read IPP responses from a server, and write IPP requests to a server.

### **3.4.4 Language Functions**

The language functions provide a standard interface for retrieving common textual messages for a particular locale and determining the correct encoding (e.g. US ASCII, ISO-8859-1, etc.)

### **3.4.5 MIME Functions**

The Multimedia Internet Mail Exchange functions manage a MIME type and conversion database that supports file typing by extension and content, and least-cost file filtering from a source to a destination file type.

### **3.4.6 PPD Functions**

The PostScript Printer Description functions manage PPD files, select options, check for option conflicts, and emit selected options in the correct order.

### **3.4.7 Raster Functions**

The raster functions manage streams of CUPS raster data (described in the Interface Design Document) used by non-PostScript printer drivers.

## **3.5 Filters**

The filters implement file conversion services for CUPS. All filters are called with a common set of arguments:

- Printer name – the name of the destination printer (name string).
- Job Identifier – the job identifier for this job (integer).
- User Name – the user associated with this job (name string).
- Title – the title/job-name associated with this job (name string).
- Copies – the number of copies required (integer).
- Options – the options associated with this job (space separated option strings).
- Filename (optional) – the file to print; if this option is not specified, the filter must read the input file from the standard input.

Filters are added to the MIME conversion data file and implement all necessary conversions from one file type to another.

### **3.5.1 hpgltops**

The hpgltops filter converts HP-GL/2 files into PostScript.

### **3.5.2 imagetops**

The imagetops filter converts image files into PostScript.

### **3.5.3 imagetoraster**

The imagetoraster filter converts image files into CUPS raster data.

### **3.5.4 pstops**

The pstops filter inserts printer-specific commands from PPD files and performs page filtering as requested by the user.

### **3.5.5 pstoraster**

The pstoraster filter converts PostScript program data into CUPS raster data.

### **3.5.6 rastertohp**

The rastertohp filter handles converting CUPS raster data to HP PCL and supports both color and black-and-white printers.

### **3.5.7 texttops**

The texttops filter converts text files into PostScript.

## **3.6 Scheduler**

The scheduler is a fully-functional HTTP/1.1 and IPP/1.0 server that manages the printers, classes, and jobs in the system. It also handles a simple broadcast-based directory service so that remote print queues and classes can be accessed transparently from the local system.

### **3.6.1 Authorization**

The authorization module is responsible for performing access control and authentication for all HTTP and IPP requests entering the system.

### **3.6.2 Classes**

The classes module is responsible for managing printer classes in the system. Each class is a collection of local and/or remote printers. The classes module also reads and writes the classes configuration file.

### **3.6.3 Client**

The client module is responsible for all HTTP client communications. It handles listening on selected interfaces, accepting connections from prospective clients, processing incoming HTTP requests, and sending HTTP responses to those requests. The client module also is responsible for executing the external CGI programs as needed to support web-based printer, class, and job status monitoring.

Once authorized, all IPP requests are sent to the IPP module.

### **3.6.4 Configuration**

The configuration module is responsible for reading the CUPS configuration file and initializing the appropriate data structures and values. The configuration module also stops CUPS services before reading the configuration file and restarts them after the configuration file has been read.

### **3.6.5 Directory Services**

The directory services module sends and receives printer state information over a broadcast socket. Remote printers and classes are automatically added to or removed from the local printer and class lists as needed.

The directory services module can only receive printer state information over a single UDP port, however it can broadcast to multiple addresses and ports as needed.

### **3.6.6 IPP**

The IPP module handles IPP requests and acts accordingly. URI validation is also performed here, as a client can post IPP data to any URI on the server which might sidestep the access control or authentication of the HTTP server.

### **3.6.7 Jobs**

The jobs module manages print jobs, starts filter and backend processes for jobs to be printed, and monitors status messages from those filters and backends.

### **3.6.8 Logging**

The logging module manages the access, error, and page log files that are generated by the scheduler.

### **3.6.9 Main**

The main module is responsible for timing out and dispatching input and output for client connections. It also watches for incoming SIGHUP and SIGCHLD signals, reloads the server configuration files as needed, and handles child process errors and exits.

### **3.6.10 Printers**

The printers module is responsible for managing printers and PPD files in the system. The printers module also reads and writes the printers configuration file.

## **3.7 System V Commands**

The System V commands provide a robust command-line interface to CUPS to submit and control printers and jobs.

### **3.7.1 accept**

The accept command tells the scheduler to accept new jobs for specific printers.

### **3.7.2 cancel**

The cancel command tells the scheduler to cancel one or more jobs that are queued for printing.

### **3.7.3 disable**

The disable command tells the scheduler to stop printing jobs on the specified printers.

### **3.7.4 enable**

The enable command tells the scheduler to start printing jobs on the specified printers.

### **3.7.5 lp**

The lp command submits files for printing. Unlike the standard System V lp command, a single CUPS lp command will generate a separate job ID for each file that is printed. Also, the Solaris "f", "H", "P", "S", and "y" options are silently ignored.

### **3.7.6 lpadmin**

The lpadmin command manages printer queues and classes. The Solaris "A", "F", "I", "M", "P", "Q", "S", "T", "U", "W", "f", "l", "m", "o", "s", "t", and "u" options are not supported, and new options "P" (PPD file), "F" (filter), and "E" (enable and accept) are provided to configure CUPS-specific features such as PPD file and conversion filters.

### **3.7.7 lpstat**

The lpstat command lists printers, classes, and jobs as requested by the user.

### **3.7.8 reject**

The reject command tells the scheduler not to accept new jobs for specific printers.





# A Glossary

## A.1 Terms

*C*

A computer language.

*parallel*

Sending or receiving data more than 1 bit at a time.

*pipe*

A one-way communications channel between two programs.

*serial*

Sending or receiving data 1 bit at a time.

*socket*

A two-way network communications channel.

## A.2 Acronyms

*ASCII*

American Standard Code for Information Interchange

*CUPS*

Common UNIX Printing System

*ESC/P*

EPSON Standard Code for Printers

*FTP*

File Transfer Protocol

*HP-GL*

Hewlett-Packard Graphics Language

*HP-PCL*

Hewlett–Packard Printer Control Language

*HP–PCL*

Hewlett–Packard Printer Job Language

*IETF*

Internet Engineering Task Force

*IPP*

Internet Printing Protocol

*ISO*

International Standards Organization

*LPD*

Line Printer Daemon

*MIME*

Multimedia Internet Mail Exchange

*PCL*

Page Control Language

*PPD*

PostScript Printer Description

*SMB*

Server Message Block

*TFTP*

Trivial File Transfer Protocol